



Going to the Dogs

Cognitive scientists once spurned the dog as too domesticated to study. But now many are leaping at the chance to use man's best friend to help understand how social cognition evolved

BUDAPEST—In 1994 when Ádám Miklósi, then a young ethologist at Eötvös Loránd University in Budapest, learned that his lab's director planned to switch the team's research from fish to dogs, he couldn't believe it. "My god, are you crazy?" That's what I thought, although I didn't say it," says Miklósi, who now directs the university's highly regarded dog cognition lab. "None of us were happy about this." At the time, scientists who studied animal behavior and cognition were busy investigating a variety of species, including ants and dolphins, but they shunned dogs because they thought the animal's domestication, and the bond between human and dog (*Canis familiaris*), precluded objective study. In fact, lab director Vilmos Csányi's interest had been spurred by his admiration for Flip, a mixed-breed dog he had found in the woods and adopted. "He would tell us some crazy story about Flip and say, 'Now, devise an experiment to find out why Flip can do that,'" says Miklósi.

Fifteen years later, in the wake of dozens of provocative studies from the Hungarian lab and a few others, dogs are fast becoming the *it* animal for evolutionary cognition research. Well-known cognitive scientist Marc Hauser of Harvard University announced in February that his lab was switching from cotton-top tamarin monkeys to dogs. Around the world, from Australia to Japan, other dog ethology and cognition labs are either fully under way or in the works. Last year, Miklósi's group held the first-ever dog cognition conference; a second is planned for July 2010 at the Clever Dog Lab and Wolf Science Center (WSC) at the University of Vienna. Last month, an issue of the journal *Behavioural Processes* was devoted to the dog, with 12 papers from behaviorists and ethologists analyzing everything from canine barking to dogs' guilty faces. And this week,

Online
sciencemag.org

Podcast interview
with author
Virginia Morell.

researchers explore how dogs evolved their social smarts in a *PloS ONE* paper comparing how young and mature dogs and wolves follow human cues. Even the shape of dogs' faces is being studied: Scientists in Miklósi's lab reported 24 July in the journal *Behavioral and Brain Functions* that dogs with rounder faces, such as pugs, are better at following people's cues than breeds with longer noses, indicating that we've selected puglike breeds not for their baby faces but for their ability to look us in the eye.

Our canine pals, researchers now say, are excellent subjects for studying the building blocks underlying mental abilities, particularly those involving social cognition. The special relationship with humans that once disqualified dogs from research is now seen as worthy of study in its own right; some researchers see the dog as a case of convergent evolution with humans because we share some similar behavioral traits. And because all dogs are descended from gray wolves (*C. lupus*), they can reveal how domestication has altered a species' mental processes, enabling the dog to survive in its new habitat, the human home. "They're a natural experiment," says Josep Call, a comparative psychologist at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, who studies cognition in dogs, wolves, and great apes.

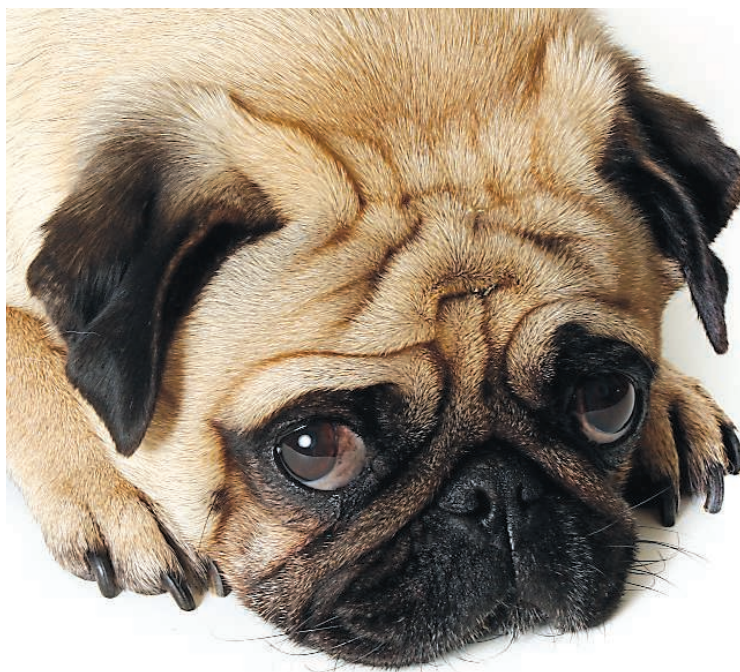
◀ **Leading the pack.** Cat lover Ádám Miklósi works with dogs in his Budapest lab.

Miklósi, Call, and others even argue that dogs may teach us more about the evolution of some aspects of our social mind than can our closest kin, the chimpanzee, because Fido is so adept at reading and responding to human communication cues. But not everyone agrees. “Completely wrong,” says Clive Wynne, a psychologist at the University of Florida, Gainesville, who argues that the skills dogs share with humans are a matter of learning rather than evolutionary change. But Wynne, who edited the special *Behavioural Processes* issue, agrees that dog ethology and cognition are hot fields. “There’s no other species on the planet that triggers so many questions and debate, and no animal that we have a more intimate relationship with, than the dog.”

Real animals?

Dogs weren’t always viewed this way. Although Charles Darwin and Ivan Pavlov considered dogs fine subjects for studying evolution and behavior, cognitive scientists and ethologists placed dogs in a kind of research purgatory for many years. In the 1970s, when cognitive ethologist Marc Bekoff of the University of Colorado, Boulder, launched a study of dog play behavior, many of his colleagues sniffed at the idea. They said “‘Why don’t you study *real* animals?’” he recalls. Domestic dogs were considered artificial and therefore “not worthy of study”—a concern that many researchers still have. Domestication makes dogs “less useful for investigations on the evolution of cognition,” says Nicola Clayton, who studies bird behavior at the University of Cambridge, U.K., “because you can’t look for the ecological effects, for what originally drove intelligence in dogs.” Also, “the investigator has no control over the nurture side: how owners feed, train, or treat their dogs,” says primatologist Frans de Waal of Emory University in Atlanta. That “introduces unknown variables we would normally not accept in animal behavior research.” Still, Clayton and de Waal support the move to dogs. When it comes to dogs, “the pros outweigh the cons,” says de Waal.

Researchers have also worried that dogs are *too* aware of human cues and so would defeat most experimenters as did Clever Hans, the horse once celebrated for tapping out answers to math problems—and later shown to be closely watching his owner for subtle clues to when he should stop tapping. To prevent this, dog ethologists carefully monitor testing methods, generally videotape experi-



Into the canine mind. Researchers are giving dogs touch-screen tests (*above*) and investigating that guilty look to understand how dogs think.

ments, and use various techniques, including blindfolding human testers, to make certain they are not inadvertently giving clues.

Dogs were also deemed to have another problem: Their brains are 25% smaller than those of their wild ancestors, wolves. “Most people thought—and some still do—that dogs were therefore not as smart as wolves,” says Call. But “brain size is not everything. ... How did domestication change wolves into dogs? Is it similar to what happened to

us? That’s the kind of thing that dogs can help us investigate.”

And despite the concerns, dogs in fact have many advantages as cognitive research subjects, say Miklósi and others. Dogs are willing and cooperative, and they enjoy being with people and following their commands. The dog’s genome has been mapped (*Science*, 21 September 2007, p. 1668), opening up the

possibility of linking behavioral traits to specific genes. To cap it all off, dogs are much less expensive to study than most laboratory animals, largely because most dog labs follow the model of Miklósi’s Family Dog Project and don’t actually house dogs (which also helps keep animal-rights activists at bay). “All you need is an empty room for a dog lab,” says biological anthropologist Brian Hare, who is busy setting up such a room at Duke University in Durham, North Carolina. “Then you ask people if they’d like to have their dogs take part in a cognitive experiment. Everybody knows their dog is smart, and the next thing you know, you have 1000 dogs to test.”

“It’s like *Drosophila* genetics,” adds Hauser. “Why stop at 1000; why not have 10,000? It’s a huge change from simply studying 30 tamarins.” Thus dog research can be replicated—a tall order when working with some other animals. “Let’s face it: No one is going to be able to replicate my bonobo studies,” says Hare, “because there isn’t another population of 60 bonobos to test.”

Reading minds

With so many dog labs joining the pack, new and provocative

findings are emerging. For example, ethologists have shown that dogs, even as puppies, can follow human pointing gestures to find hidden food, something difficult for chimpanzees to do (*Science*, 22 November 2002, p. 1634). The experiments suggest that dogs can read human intentions, implying that the two species share information via a complex form of communication. Even more controversially, the discovery suggests to some that dogs may understand what another being is



Raised by humans. Wolf cubs raised like dog puppies (top) play with dogs and grow up to be as good as adult dogs at following human pointing cues in experiments.

thinking, a sophisticated talent called theory of mind that many researchers think even chimpanzees and preverbal human infants lack.

Dogs can also imitate a human's actions on command ("Do as I do!"), much like children playing "Simon Says," according to studies done by Miklósi's colleague József Topál and his team at the Institute for Psychology at the Hungarian Academy of Sciences in Budapest. That's an indication that dogs are strong social learners, something still debated for chimpanzees. "They've been selected for this sensitivity and to cooperate," says Miklósi, who confesses to being a cat person and has never owned a dog. Dogs can also use computer touch-screens to demonstrate some glimmerings of abstract thought, such as the ability to form a concept. For example, dogs were able to select color photographs of other dogs instead of landscapes, choosing with a quick nose-touch to the screen. Pooches can follow human rules, a social skill that helps strengthen group bonds; they have a sense of fairness; and some canine whizzes—all Border collies so far—have vocabularies of several hundred names, suggesting an ability to learn words that some say resembles that of infant children. Also like human toddlers, dogs willingly imitate another's actions, even if these don't always

make sense, an ability that makes it easy to learn from others. In short, dogs are skilled at cognitive tasks, especially social tasks requiring cooperation and sharing information to achieve a goal.

Sometimes these advanced social skills lead dogs to behaviors and emotions that seem very humanlike. But are they? Take the "guilty look" every dog owner knows. While cameras rolled, Alexandra Horowitz, an animal cognition researcher at Barnard College in New York City, had 14 owners show their dogs a tasty treat and tell them not to eat it. But when the owner left the room, Horowitz either gave the dog the forbidden food or removed it, making it impossible for the pooch to misbehave. Later, some owners were told that their dogs ate the treat, even when they had not. "It didn't matter if the dogs had done the right thing. If they were scolded, they showed that guilty look," slinking away with their heads drooping and ears flattened, says Horowitz, whose work is published in the July issue of *Behavioural Processes*. "And the dogs who showed the most 'guilt' were the ones that hadn't disobeyed. We've trained them to give us that look" in response to our anger. "The guilty look is not necessarily a reflection of anything they have done," she says. Adds Michael Tomasello, a comparative cognition researcher also at the Max Planck Institute in Leipzig: "Guilt involves a moral dimension, which dogs very likely don't have. But by showing guilt, we may lessen our punish-

ment. What people see in dogs is the anticipation of punishment." In humans, says Tomasello, that anticipation is regarded as a "precursor to guilt."

Indeed, some researchers think that the evolutionary steps gray wolves took to live in human society may in some ways mirror the transition from ape to human. The loss of fear and aggression toward others and the emphasis on cooperation rather than competition are steps that early hominids must also have taken as they organized into groups, although for dogs the change also required evolving a deep attachment to an entirely different species. "Dogs have lived with us for at least 10,000 years, and they've evolved to fit into our social world, so they've developed some social and behavioral skills strikingly like ours. It's a case of convergent coevolution," says Call.

Wynne's having none of the coevolution argument, however. "Dogs and wolves are still the same species," he says. "They still interbreed, and so any changes in the dog's brain are a matter of degree rather than kind." And he is skeptical of some of the claims regarding dogs' abilities, particularly those that suggest superior mind-reading skills as compared with wolves. "Sometimes I feel that I'm always running after other people, stomping out the fires they've started" with claims of dogs' advanced abilities, he says. He argues that the Border collies with fat vocabularies are merely "conditioned" and that their talent for picking up human sounds is not at all comparable to

how children learn words. “If they were really like children, they’d be learning hundreds of words a day,” he says.

From wolf to dog

Despite Wynne’s concerns, for many the evolutionary process that produced the dog is fertile ground for research. Most agree that domestication changed the dog dramatically, turning it into a creature who yearns to be with a species other than its own. Researchers hypothesize that this happened because humans selected dogs for their ability to socialize and to form strong attachments with people. Indeed, experiments in Miklósi’s lab have shown that 4-month-old puppies in a choice test always preferred a human companion to a dog. Young wolves showed no preference. “Domestication changed” the dog brain, “making it more attuned to human social signals,” says Miklósi.

To test that idea, scientists have examined how well dogs and wolves can pay attention to human pointing cues and hold eye contact with people. (Wild wolves, like many wild mammals, are reluctant to make eye contact, perhaps because in many species staring is a threat.) Previous pointing studies had mixed results: In the original tests, dogs proved to be superior to wolves (and chimpanzees) in following a human’s finger to a bucket that held a hidden food treat. Many researchers interpreted this as an indication of a genetic component to this skill, one favored by domestication. But later tests complicated the issue: In another study using a different method, wolves actually topped the hounds.

To clarify the question of just what wolves can do, Márta Gácsi of Miklósi’s lab and her co-authors hand-raised gray wolves much as pet dogs are raised, as they report this week in *PLoS ONE*. Then they gave carefully designed pointing tests to wolves and dogs of different ages. Intriguingly, 8-week-old and 4.5-year-old wolves were as good as the dogs at following the human pointing cues to hidden food. But the 4-month-old wolves failed. “They were struggling and biting; they were just too busy doing other things,” says co-author Friederike Range of WSC. In addition, in contrast to the young dogs, the young wolves had trouble making eye contact with their humans. “They are on a different developmental path from dogs,” perhaps because ultimately dogs “must live in our world and obey our rules. They have to learn many of the same things that children learn,” says Range. And so it behooves dog puppies to look into their owners’ eyes and pay attention.

“The study is a slam dunk,” says Hare, who says it shows “once again that dogs and wolves are different.” He and others say that the study reveals that dogs are born ready and willing to work with people, whereas wolves face a long learning curve before they can accept two-legged creatures as social partners. But because the wolves *can* learn over their lifetime to follow our cues, the study also points out how difficult it is to “unravel genetic factors” from socialization and training, notes de Waal.

“We have so many questions to ask,” says Miklósi. “What do dogs understand about verbal commands? How do they recognize their owners? What do they think of as sig-

warnings or to protest. In contrast, dogs bark for many reasons, says Miklósi. “They ‘invented’ barking,” as a means of communicating to us as much as to other dogs, and they “can modulate the frequency and pulse” to signal fear or that they are feeling lonely or playful. In a previous study, Peter Pongrácz in Miklósi’s lab showed that humans can readily identify the differing barks of a lonely, fighting, or playing dog. “That means that a dog’s bark is often directed at us to convey the dog’s inner state,” Pongrácz says, an ability that has likely come about because dogs live with a talkative species.

As part of his ongoing, as-yet-unpublished study of dog-human communication, Tamás Faragó, one of Pongrácz’s graduate students, covered a small cage with a cloth and placed a large, tempting bone close by. Kope, a bright-eyed Cairn terrier, trotted in off-leash with his owner, spied the bone, and made a beeline for it. But just as Kope reached the bone, Faragó played a recorded growl, and the dog froze in place. “That’s a food-guarding growl,” Faragó whispered. “As soon as a dog hears that, he knows he better leave that bone alone.” When the unseen dog growled a second time, Kope, looking unnerved, ran halfway back to his owner, wagging his tail. He peered up at her face, then looked back over his shoulder at the bone. “He’s asking for help,” Faragó explained. “‘Come on, Mommy, help me get that bone. Let’s do it together.’”

That, say Miklósi and others, is what lies at the heart of dog cognition: their strong desire to work with and for us, and their ability to communicate with us without language. “That’s the one thing all of us doing dog research must never forget,” says Tomasello. “Dogs are collaborating with us; they aren’t doing this with other dogs.” Unraveling how that collaboration came about—how it turned wolves into dogs, and humans into dog lovers—is like a good bone: one well worth digging for.

—VIRGINIA MORELL



The changeling. Domestication turned gray wolves into cooperative dogs attuned to human social cues.

nificant in their environment? What does a dog understand about human relationships; what does he know about your state of mind? And then we should ask the wolves the same questions.”

On one recent day, dogs and their owners stopped by to join in an experiment at the Hungarian lab, investigating how dogs respond to certain growls, part of a larger study aimed at understanding how dogs’ barks and growls have changed from those of wolves. Wolves bark, too, but only as